ELECTRICAL APPRENTICESHIP CURRICULUM OUTLINE FY2012 YEAR 2

Electrical Training: **162 hours**

First Semester & Yearly Final Exams: **6 hours**

Total Hours: **168 hours**

Each of the following subjects may take more or less time than is shown, but a minimum of 144 hours is required. The instructor should concentrate on the student achieving the basic objectives stated. The math and theory portion should not be hurried as this is foundational for the next four years.

Recommended Textbooks for PTE Schools:

Delmar's Standard Textbook of Electricity
National Electrical Code (NEC)
Electricians Exam Prep
Ugly's Electrical Safety and 70E
Ugly's Electrical Reference

Safety and NFPA70E

Incorporate discussions and test questions based on electrical safety and NFPA 70E in the following areas of study as is appropriate. This is an extension of the basic safety introduced in year one.

Note: An *asterisk indicates "green" attributes in the studies

REVIEW: Ohm's Law and Series, Parallel and Combination Circuits

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Demonstrate basic competencies in calculating series, parallel, and combination circuits using the Ohm's law wheel

Basis Trigonometry

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Define a right triangle
- Use the Pythagorean theorem to solve problems concerning right triangles
- Solve problems using sines, cosines, and tangents

Alternating Current

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Discuss the difference between AC and DC
- Compute instantaneous values of voltage and current for a sine wave
- Compute peak, RMS, and average values of voltage and current
- Define the phase relationship of voltage and current in a pure resistive circuit

Inductance in AC Circuits

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Define the properties of inductance in an AC circuit
- Discuss inductive reactance
- Calculate the values of inductive reactance and inductance
- Define the relationship of voltage and current in a pure inductive circuit
- Calculate values for inductors connected in series and parallel
- Define reactive power
- Define the Q of a coil

Resistive-Inductive Series Circuits

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Define the relationship of resistance and inductance in an AC circuit
- Define power factor
- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RL series circuit
- Calculate the phase angle for current and voltage in an RL circuit
- Connect an RL series circuit and take measurements using test instruments

Resistive-Inductive Parallel Circuits

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Define the operation of a parallel circuit containing resistance and inductance

- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RL parallel circuit
- Connect an RL parallel circuit and measure circuit values using test instruments

***Capacitors**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- List three factors that detriment the capacitance of a capacitor
- Discuss the electrostatic charge
- State the difference between polarized and non-polarized capacitors
- Calculate the values for series and parallel connections of capacitors

*Note that power factor correction is and always has been "green." That is why the studies concerning capacitance are so identified. Though the watts consumed do not change for a facility with, say, 80% power factor, the power company needs to deliver less total volt-amps if it is corrected.

***Capacitance in AC Circuits**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Explain why current appears to flow through a capacitor when connected to an AC circuit
- Define capacitive reactance
- Calculate the value of capacitive reactance in an AC circuit
- Calculate the value of capacitance in an AC circuit
- Explain the relationship of voltage and resistance in an AC circuit

***Resistive-Capacitive Series Circuits**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Explain the relationship of resistance and capacitance in an AC series circuit
- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RC series circuit
- Calculate the phase angle for current and voltage in an RC series circuit
- Connect an RC series circuit and make measurements using test insturments

***Resistive-Capacitive Parallel Circuits**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Define the operation of a parallel circuit containing resistance and capacitance
- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RC parallel circuit
- Connect an RC parallel circuit and measure circuit values using test instruments

***Resistive-Inductive-Capacitive Series Circuits**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Explain AC circuits that contain resistance, inductance, and capacitance connected in series

- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RLC series circuit

***Resistive-Inductive-Capacitive Parallel Circuits**

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Explain AC circuits that contain resistance, inductance, and capacitance connected in parallel
- Calculate the values of voltage, current, apparent power, true power, reactive power, impedance, resistance, inductive reactance, and power factor in an RLC parallel circuit

Three-Phase Circuits

Objectives: 9 hours

At the completion of this lesson the student should be able to:

- Explain the difference between single-phase and three-phase voltages
- Draw a three-phase delta or wye connection
- Calculate the voltage and current values for wye and delta circuits

Single-Phase Transformers

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Explain the difference between an isolation-transformer and an auto-transformer and how they work
- Calculate the values of voltage, current, and turns for a single-phase transformer
- Connect a transformer and test the voltage output of different windings
- Explain the polarity markings

Three-Phase Transformers

Note: Some of following objectives are closely related to the three-phase circuit subject matter already studied. Some of this is like a review and reinforcement

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Connect three single-phase transformers to form a three-phase bank
- Calculate voltage and current for three-phase transformer connections
- Connect two single phase transformers to form a three-phase open-delta connection
- Calculate the values of voltage and current for a three-phase transformer used to supply both three-phase and single-phase loads
- Define what a harmonic is.
- Discuss harmonic problems and their solution.

Three-phase Motors

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Discuss the basis operating principals of a three-phase motor
- Explain a rotating magnetic field
- Discuss the operating principals of a squirrel-cage motor
- Connect dual voltage motors for correct operation on the desired voltage
- Reverse a three-phase motor by changing connections

Single-phase Motors

Objectives: 6 hours

At the completion of this lesson the student should be able to:

- Reference the operation of various motor types
- Explain the basic operation of a split-phase motor
- Explain a starting winding and how it works
- Explain the operation of a centrifugal switch
- Recognize the types starting relays

Motor Load Calculations

Objectives: 12 hours

At the completion of this lesson the student should be able to:

- Determine the full load current of any motor according to the NEC
- Size the branch circuit wire size for any motor
- Determine the appropriate circuit protection for any motor
- Use the motor name plate to size overloads
- Explain the difference between overload protection and short-circuit/ground-fault protection
- Size a feeder for any set of motors
- Size the feeder overcurrent device

Box Fill and Junction Box Sizing

Objectives: 9 hours

At the completion of this lesson the student should be able to:

- Calculate box fill for any size wire and combination of devices
- Properly size pull and junction boxes

Conductor Ampacity Correction Factors

Objectives: 9 hours

At the completion of this lesson the student should be able to:

- Calculate correction factors for temperature
- Calculate correction for raceway fill
- Calculate correction factors for continuous loads
- Calculate correction factors for any combination of the above
- Properly use table 310.15(B)(16) and similar tables
- Properly apply NEC Chapter 9 notes for derate in nipples

Raceway Fill

Objectives: 9 hours

At the completion of this lesson the student should be able to:

- Use NEC tables to calculate raceway fill using any combination of wire sizes
- Properly use Annex C tables
- Properly fill conduit nipple

Grounding and Bonding

Objectives: 18 hours

At the completion of this lesson the student should be able to:

- Define objectionable current
- Define a main bonding jumper
- Properly size the grounding electrode conductor
- Properly install the grounding electrode system
- Explain the purpose of bonding
- Properly size equipment grounding conductors
- Use article 250 to properly ground and bond any system
- Effectively use the NEC to answer any grounding question

.